



The Electric Paperless Prototype

Everybody's favorite digital fantasy of living a paperless life got a two-year tryout in the glass ark of Biosphere 2. Kevin Kelly visits and finds it's still a fantasy.

By Kevin Kelly

Whatever else you might say about the Biosphere 2 experiment in Arizona, you've got to give the eight people who agreed to be sealed in a glass bottle for two years credit for this: They are the only folks so far to attempt to live an information-intensive life without paper. For 24 months nothing was to be brought in or out of the sealed ark. Paperless existence became one of the first obvious design goals.

Sure, lots of people have talked about paperless life, and many have actually taken vows to reduce their paper consumption and recycle what they do use. But to my knowledge, the biospherians are the only ones to have tried living out the fantasy for any length of time. In September 1993, when the eight bionauts marched out of their big glass house, they had a lot to say about the feasibility of living without paper. Their message: "Paperless life is just possible."

An airtight glass ark the size of an ocean liner, Biosphere is stuffed with seven very dense and compact ecosystems ranging from a bona fide rain forest to a small coral reef lagoon. It is also stuffed with some of the most complex mechanical systems built -- for air, water, heat, electricity, and information. During their stint inside, the biospherians were expected to raise their own food, keep the weeds down in the wilderness areas, keep all the machines running, and write scientific papers. To do this, they ordinarily processed the following hunks of data and information: Each day they completed a checklist noting the working status of 60 motors, 50 miles of cables, 100 pumps, and innumerable valves. They were in 24-hour radio contact with colleagues inside the big ark and outside at mission control, 300 feet away. They recorded every bit of food harvested, how much it weighed, how much was eaten (as well as how many calories it contained), and how much matter was returned to compost. They frequently connected via videoconferencing hookups to classrooms around the world. They exchanged their atmospheric data with scientists outside and organized six scientific workshops altogether with these far-flung participants. They recorded their water use and where the water went. They measured plant growth and mapped species movements within the ark. They received electronic faxes of late-breaking news. They got cable TV. They worked on scientific papers to be published, complete with peer reviews from outside scientists and extensive citations of other papers. They sent and received volumes of internal e-mail regarding everyday management of their project. A few of them ventured into the Internet cloud to seek information and companionship; this added exponential numbers of e-mail messages and list postings. Half of the biospherians were involved in managing businesses or second jobs while inside. And about half also pursued advanced academic degrees during their two years away from paper. These folks were not digital slouches.

In between the first and second "closures" of Biosphere 2, I visited the site to see how close to paperless the biospherians actually got. Their human habitat, as they like to call it, was amazingly spacious, ultimately modern. They enjoyed a large meeting/dining room/kitchen area, outfitted with plush lavender carpet and marblish decorating touches. There was a phone at every corner. Indeed, there were phones hidden throughout the place, even in the wilderness area. Inside each apartment was a computer with a modem, as well as a bed, storage space, a phone, and TV. Each biospherian

also had a computer in a common workplace.

By and large, the bulk of the information processing was done from the biospherians' personal desktops. Although they brought in laptops, they didn't use them portably. They didn't find palmtops or personal digital assistants (PDAs) to be of much use for their chores either. The biospherians (ecoserfs I called them) used their hands a lot in manual labor. They said what they wanted was "handless" voice input, so they could read out data as they harvested crops or hauled compost. Lacking this device, the biospherians would sometimes use their walkie-talkies as a substitute. As their hands sized up plants, they would speak the measurements into the radio, while someone outside would jot down the numbers on a computer and relay the data back to them inside to check. Not very elegant, but it worked.

Even though they managed to forgo paper in the bathroom, in reality biospherian life was not completely paperless. Paper was used for field notebooks with pencil "input." There's something about the compact reliability of a notebook that is still hard to beat. They also had a book library -- eclectically stocked -- which reminded me of the odd lots of books you find shelved in vacation cottages.

Outside of the field notebooks and this library, the ark buzzed with data. Noberto Alvarez-Romo, the project's director of cybernetics, calculates that the biospherians collectively received 10,000 faxes. These faxes never saw paper, having been projected instead onto desktop computer screens. The resolution was adequate for reading them, except when material was faxed sideways.

Somewhat surprisingly, Biosphere 2 was not wired with fiber-optic cable. Instead, it used coaxial cable, which, given the short distance, proved to be cheaper to install and maintain. Videoconferences took place on a regular basis. There were several stations inside where the biospherians could link up with fixed cameras and cabling. The best reception was via PictureTel, whose pictures ran over high-bandwidth telephone lines. I participated at the other end of one hookup with the biospherians; the quality was impressive. There was a slight, ragged delay between Arizona and San Francisco, but overall the picture and sound reminded me of a home videotape -- only in real time.

The biospherians were big on e-mail. Since they were in the limelight, they encountered about a 10-to-1 ratio of inbound mail to their outbound. In addition to reading Usenet groups, some biospherians also participated in forums on PeaceNet, EcoNet, and the Well.

Biosphere 2's grand experiment was to determine what could be learned from a self-sustaining closed system -- nothing in, nothing out, except energy and information. But in the second year of the mission, the Biosphere Scientific Advisory Committee recommended that the scientists relax their strict import rules and allow some paper into the bottle, as long as the material was recorded. So on request, the biospherians could import needed medical journals (they experienced low oxygen conditions inside) and research documents for their own scientific papers and classes (diagrams in journals turn to mud during faxing).

The printed matter the biospherians most requested (but never got) was TV Guide. The support crew balked at having to fax it in so often. I got the impression the biospherians had their sets tuned to CNN Headline News as a default. To compensate for a lack of TV schedule listings, the support center served as a minor video-on-demand center. The biospherians sent constant requests asking the support crew to load rented, newly released movies into the VCR outside and pipe them into the ark. Saturday nights quickly evolved into Double Feature Night.

A few biospherians got desperate enough for text news to have an entire book faxed in or e-mailed in as ASCII. The slight hardship of reading a book on screen and not being able to mark it, as well as the long downloading time needed to get the text, dampened their enthusiasm for electronic books. Less than a dozen paperless books were read in the first "closure."

The point of Biosphere 2 was to demonstrate that no organism or habitat is an island. One of the biospherians, Linda Leigh, said of her try at a paperless habit, "We discovered that true paperless

living requires lots of people outside who are also paperless. You can't really be an island of paperless life." Linda explained that she could only write to others via e-mail or fax, and many recipients had only paper fax machines. Thus she generated more paper than she wanted to. Ordinary paper letters mailed to the biospherians had to be opened, scanned in as faxes, read over the phone, or held up to a window -- all time-consuming activities. Even with that help, twelve boxes of paper mail awaited the biospherians' re-entry.

The most common complaint the biospherians had about living without paper was that they couldn't find stuff after they had filed it. After storing two years' worth of personal, work-related, and media and news data (estimated at 4 gigabytes of information per biospherian) little bits of it seemed to disappear easily. Paper can get lost too, of course, but the visual clues provided by paper on a desk or shelf do make it easier to retrieve.

On March 6, 1994, a second crew of six biospherians sealed themselves up for ten months of paperless life. They are experimenting with one or two palmtops and have upgraded their IBM clones with more RAM and power. They've installed more portable and remotely controllable video cameras. And for future missions they are putting more of their operating manuals online in the form of custom CD-ROMs.

The original Biosphere crew felt they came within 80 percent of being comfortably paperless. They could live with reading everything

on a screen. They delighted in creating purely digitized data for others, and they loved the immediacy of e-mail and video hookups. But they missed newspapers and magazines. Their primary request was for two major advances: improvements over hand-generated input in the field and superior tools for retrieving, managing, and coordinating gigabytes of stored electronic information. Oh, and they never figured out a way to legitimately create their "signatures" for paper forms that demanded them. They used what the second crew will use: a person outside with power of attorney.

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